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BUILDING UTILITIES FOR 7 GeV ADVANCED PHOTON SOURCE BASED ON MAXIMUM COMPONENT DESIGN OF 7.7 GeV

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Building Utilities for 7 GeV Advanced Photon Source Based on Maximum Component Design of 7.7 GeV.

The building utilities, electrical power and cooling water requirements, were estimated for the 7 GeV Advanced Photon Source by:

1. Developing an estimate of electrical power required for each beam line inside and outside the storage ring tunnel. This was then used to estimate the heat loss to the cooling water system and the heat loss to the air. The estimate of power, heat loss and location is shown in Fig. 1.

2. Developing an estimate of electrical power required for each RF system in the storage ring, taking into account the efficiency of converting from ac to dc to RF and finally to the beam. This was then used to estimate the heat loss to the cooling water system and the heat loss to the air. The estimate of power, heat loss and location is shown in Fig. 2.

3. Developing an estimate of electrical power required for the storage ring vacuum system. This and the worst case beam loss was then used to estimate the heat loss to the cooling water system and the heat loss to the air. The estimate of power, heat loss and location is shown in Fig. 3.

4. Developing an estimate of electrical power conversion and transport efficiency from the ac line to the magnet load. This was then used to estimate the heat loss to the cooling water system and the heat loss to the air. The estimate of power, heat loss and location is shown in Fig. 4.

5. Developing an estimate of general requirements for electrical power for lighting, receptacles, buildings, HVAC systems and HV systems as follows:

5.1 LIGHTING

5.1.1 OFFICES ($32.3 W/m^2$)

5.1.2 EXPERIMENTAL HALL ($10.8\ W/m^2$)

5.1.3 TUNNELS ($10.8\ W/m^2$)

5.2 RECEPTACLES

5.2.1 OFFICES (46 kW) 25% UTILITY--75% CLEAN

5.2.2 LABS (54 kW) 75% UTILITY--25% CLEAN

5.2.3 HI BAY LABS (100 kW)

5.3 BUILDINGS

5.3.1 STORAGE RING AND EXPERIMENTAL HALL BUILDING (25000 W EVERY 10 m AROUND THE OUTSIDE OF BUILDING) AND 12.5 kW EVERY 10 m AROUND THE INSIDE OF THE BUILDING.

5.3.2 TUNNELS (25000 W EVERY 10 m) EXCEPT STORAGE RING
Note 4/15/87
- add 100 kW in each of 2 locations (by RF cavities for vacuum bake out carts--G. Nicholls).
- vacuum pumps is allocated 10 kW every 10 m.

5.3.3 STORAGE RING TUNNELS (3.75 kW VACUUM and 5 kW OTHER EVERY 10 m, PLUS 35 kW FOR EACH BEAM LINE, PLUS 100 kW FOR EVERY TWO SECTORS FOR VACUUM BAKEOUT).

5.4 HVAC and HV

5.4.1 UTILITY POWER FOR HVAC IS EQUAL TO 1.4 kW/24.16 m^2 IN ALL AIR CONDITIONED BUILDINGS BUT THE STORAGE RING & EXPERIMENTAL HALL WHERE IT IS MULTIPLIED BY 2 DUE TO THE HEIGHT OF THE BUILDING.

5.4.2 UTILITY POWER FOR HV IS EQUAL TO 0.25 kW /24.16 m^2 IN ALL BUILDINGS WITHOUT AIR CONDITIONING.

6. The cooling water system was defined as:

6.1 ALL WATER FLOW WAS CALCULATED FOR A TEMPERATURE RISE OF 13.89 C WITH APRESSURE DROP OF 100 PSI FOR 5°C WATER SYSTEM AND A PRESSURE DROP OF 150 PSI FORTHE 32.2° C WATER SYSTEM.

6.2 ELECTRICAL POWER FOR PUMPING THE 32.2° C WATER IS FOR PUMPING IT 2 TIMES.

6.3 ELECTRICAL POWER FOR 5° C WATER IS FOR PUMPING IT 2 TIMES AND COOLING IT WITH A RATIO OF PUMPED TO COOLED OF 1.4/0.4.

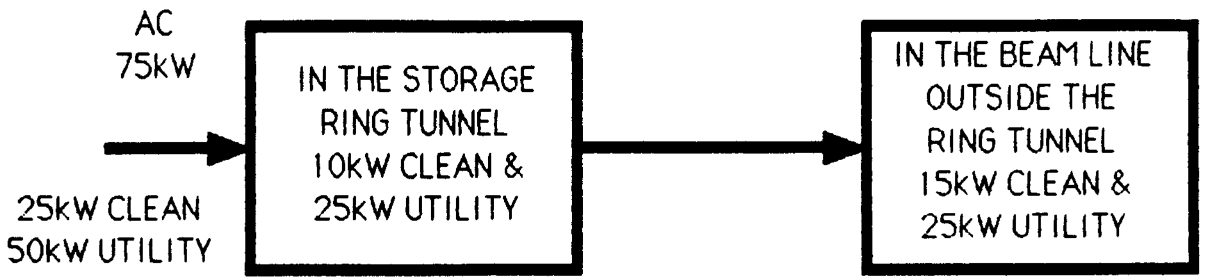
6.4 COOLING WATER EQUAL TO 100 kW LOAD FOR BOTH 5° C AND 32.2° C WATER WILL BE INSTALLED IN EACH LARGE LAB. THE HI BAY AREA WILL HAVE COOLING WATER EQUAL TO 500 kW LOAD FOR BOTH 5° C AND 32.2° C WATER.

Using the rationale developed above and the location for machine technical components, the spreadsheet of Fig. 6 was produced and transmitted to Lester B. Knight in February, 1987. This spreadsheet was then used as a basis for estimating the electrical power, cooling water, HVAC and HV requirements and distribution for the site and individual buildings.

DM:er

BEAM LINE SYSTEM POWER DISTRIBUTION AND COOLING

@ 7.7 GeV--200mA (EACH BEAM LINE)



ELECTRICAL POWER LOSS
35kW
TO WATER (20%) 7kW
TO AIR (80%) 28kW
BEAM LOSS 10kW
TO WATER (80%) 8KW
TO AIR (20%) 2kW

ELECTRICAL POWER LOSS
40kW
TO WATER (20%) 8kW
TO AIR (80%) 32kW
BEAM LOSS 10kW
TO WATER (80%) 8KW
TO AIR (20%) 2kW

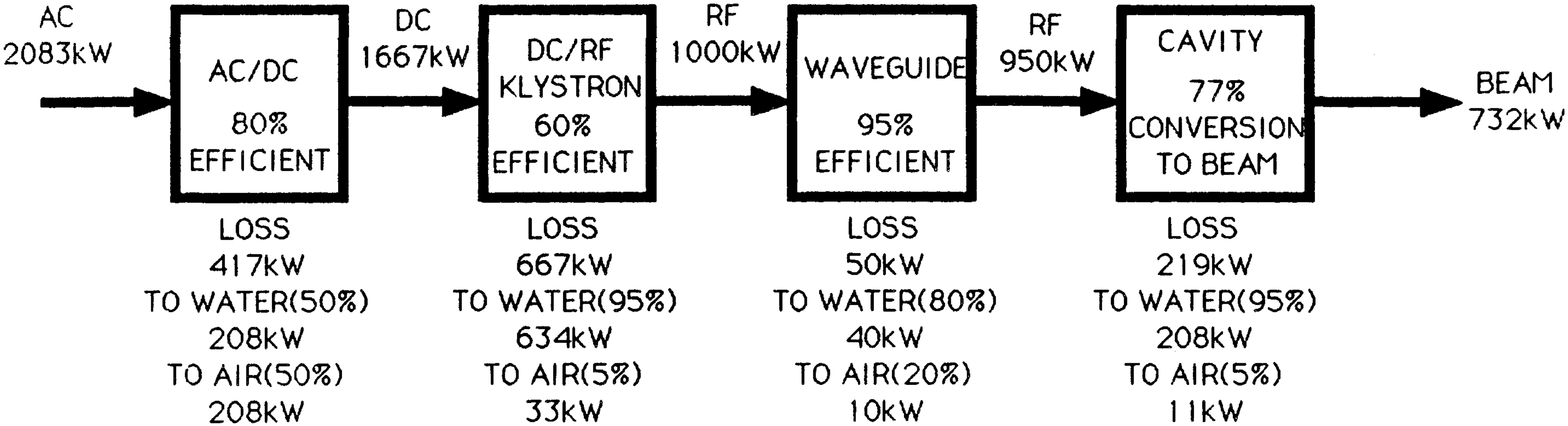
NOTES:

1. THE EQUIPMENT COOLING WATER
   - INLET TEMPERATURE 26.7°C
   - MAX. PRESSURE ≤200 PSI
   - NORMAL SUPPLY PRESSURE ≤150PSI
   - NORMAL RETURN PRESSURE ≤ 50PSI
2. BEAM LOSS WOULD BE EITHER IN THE TUNNEL OR THE EXTERNIAL BEAM LINE. ALSO THE BEAM LOSS COULD BE 1/2 kW, 1 kW, OR 10 kW DEPENDING ON THE TYPE OF BEAM.
3. APPROXIMATELY 10 kW UTILITY POWER IN EACH LOCATION IS FOR VACUUM SYSTEM BAKE OUT. .

FIGURE 1

RF SYSTEM POWER DISTRIBUTION AND COOLING

@ 7.7 GeV--200mA (1 OF 4 FOR THE STORAGE RING AND ONE FOR THE SYNCHROTRON)



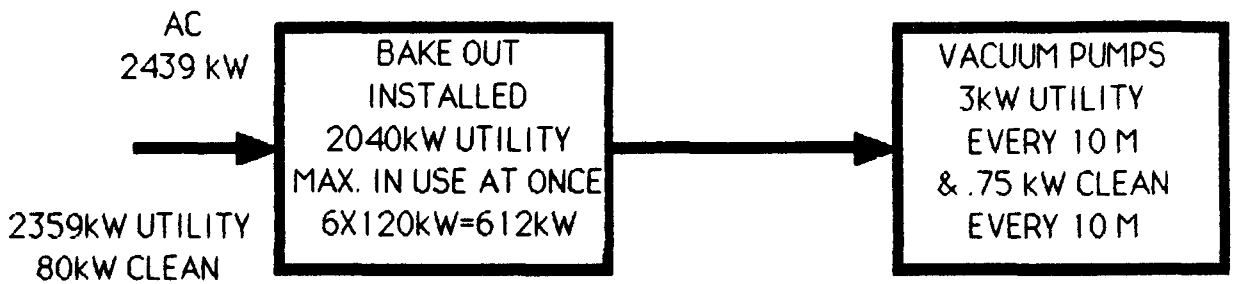
NOTES:

1. THE KLYSTRON COOLING WATER
   - INLET TEMPERATURE 26.7°C
   - MAX. INLET TEMPERATURE 40°C
   - MAX. OUTLET TEMPERATURE 90°C
   - MAX. PRESSURE ≤118 PSI
   - COLLECTOR--383 GPM--14.7 PSI
   - BODY--4.8 GPM--73.5PSI
   - OUTPUT CAVITY--7.4--73.5PSI
2. THE CAVITY COOLING WILL BE WITH <150 PSI SUPPLY AND ≤50PSI RETURN WATER WITH A TERMPERATURE RISE OF 10 TO 20°C.
3. AIR TO COOL THE WAVEGUIDE WINDOW ● 1000CFM--2" WATER.

FIGURE 2

VACUUM SYSTEM POWER DISTRIBUTION AND COOLING

@ 7.7 GeV--200mA (IN THE STORAGE RING VACUUM)



ELECTRICAL POWER LOSS
612kW
TO WATER (20%) 122kW
TO AIR (80%) 490kW

ELECTRICAL POWER LOSS
399kW
TO WATER (20%) 80kW
TO AIR (80%) 319kW
BEAM LOSS 2928kW
TO WATER (95%) 2782KW
TO AIR (5%) 146kW

NOTES:

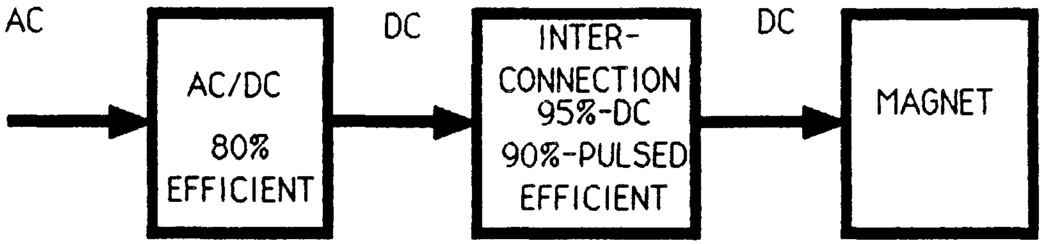
1. THE EQUIPMENT COOLING WATER
   - INLET TEMPERATURE 5°C
   - MAX. PRESSURE ≤200 PSI
   - NORMAL SUPPLY PRESSURE ≤100PSI
   - NORMAL RETURN PRESSURE ≤ 50PSI
2. BEAM LOSS IS EQUAL TO THE MAX. RF ENERGY TO THE BEAM..

FIGURE 3

APS-UTILITIES:MAGNET-LOSSES--2/12/87

MAGNET SYSTEM POWER DISTRIBUTION AND COOLING

@ 7.7 GeV--200mA



LOSS	LOSS	LOSS
ON LARGE POWER SUPPLIES (HI VOLTAGE)	ON DC MAGNETS (STORAGE RING)	ON DC MAGNETS (STORAGE RING)
TO WATER(50%)	TO WATER(0%)	TO WATER(95%)
TO AIR(50%)	TO AIR(100%)	TO AIR(5%)
ON POWER SUPPLIES (HI CURRENT)	ON AC MAGNETS (SYNCHROTRON)	ON AC MAGNETS (SYNCHROTRON)
TO WATER(80%)	TO WATER(0%)	TO WATER(90%)
TO AIR(20%)	TO AIR(100%)	TO AIR(10%)

NOTES:

1. THE MAGENT COOLING WATER
   - INLET TEMPERATURE 26.7°C
   - MAX. PRESSURE ≤200 PSI
   - NORMAL SUPPLY PRESSURE ≤150PSI
   - NORMAL RETURN PRESSURE ≤ 50PSI
2. WATER FOR PULSED POWER SUPPLIES IS BASED ON PEAK POWER.
3. WATER FOR PULSED MAGNETS IS BASED ON THE RMS POWER.

FIGURE 4

APS Bldg-specW--4/20/87
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Building Specifications for the Advanced Photon Source--7.7 GeV

BUILDING	NO.	EQUIVALENT LENGTH-m	EQUIVALENT WIDTH-m	HEIGHT-m	GROSS FLOOR AREA-m^2
1. INFIELD BUILDINGS					
1.1 LINAC	1	83.1	13.8		1146.78
1.1.1 LINAC-KLYSTRON GALLERY	1	83.1	6.9	5.8	573.39
1.1.1.1 DC POWER SUPPLIES	1				
1.1.2 LINAC TUNNEL	1	86.1	2.8	2.7	241.08
1.1.2.1 RF-COMPONENTS & MAGNETS					
1.2 INJECTOR BUILDING	1	49.8	29.2	6.1	1454.16
1.2.1 EQUIPMENT					
1.2.1.1.1 INJECTION KICKER	1				
1.2.1.1.2 PULSED INJECTION SEPTUM	1				
1.2.1.2 DIPOLE POWER SUPPLY	2				
1.2.1.3 QUADRUPOLE POWER SUPPLY	2				
1.2.1.4 SEXTUPOLE POWER SUPPLY	2				
1.2.1.5 CORRECTION POWER SUPPLY	80				
1.2.1.6 RF DC POWER SUPPLY	1				
1.2.1.7 KLYSTRON 350.8MHz	1				
1.2.1.8 AMPLIFIER 43.88MHz	1				
1.2.1.9.1 BEAM LINE BM POWER SUPPLY	1				
1.2.1.9.2 BEAM LINE QM POWER SUPPLY	12				
1.2.2 OFFICE	2	3.1	2.8		17.36
1.2.3 LAB	3	5.8	3.1		53.94
1.2.4 CONTROL ROOM	1	8.3	6.7		55.61
1.2.5 WASH ROOM-WITH SHOWER	2	5.6	3.3		36.96
1.2.6 RELAY RACK ROOM	1	4.7	2.2		10.34
1.2.7 ELEVATOR	1	1.4	1.4		1.96
1.2.8 UTILITY ROOM	1	2.2	2.2		4.84
1.2.9 ELECTRONICS ROOM	1	6.1	4.2		25.62
1.2.10 STAIRS	1	5.8	1.94		11.252
1.2.11 HOIST	1				
1.2.12 HATCH	1	5.4	2.5		13.5
1.3 SYNCHROTRON	1				
1.3.1 SYNCHROTRON TUNNEL	1	344.4	2.8		964.32
1.3.1.1 EQUIPMENT					
1.3.1.2.1 INJECTION KICKER					
1.3.1.2.2 PULSED INJECTION SEPTUM					
1.3.1.2.3 EXTRACTION KICKER					
1.3.1.2.4 PULSED EXTRACTION SEPTUM					
1.3.1.2.5 THIN DC EXTRACTION SEPTUM					
1.3.1.2.6 THICK DC EXTRACTION SEPTUM					
1.3.1.3 DIPOLE MAGNETS	68				
1.3.1.4 QUADROUPLE MAGNETS	80				
1.3.1.5 SEXTUPOLE MAGNETS	68				
1.3.1.6 CORRECTION MAGNETS	80				
1.3.1.7 RF CAVITY	8				
1.3.1.8 VACUUM FOR RF CAVITYS (BAKE OUT)	2				
1.4 EXTRACTION BUILDING	1	48	19.4		776
1.4.1 EQUIPMENT					

BUILDING	GROSS VOLUME-m^3	AIR HANDING	UTILITY LIGHTING (kW)	TOTAL PEAK ELECTRICAL POWER UTILITY (kW)	CLEAN (kW)	ELECTRICAL POWER USED TO CALULATE PEAK COOLING WATER LOAD kW EACH UNIT	TOTAL kW	COOLING WATER 5°C-GPM	COOLING WATER 26.7°C-GPM
1. INFIELD BUILDINGS									
1.1 LINAC									
1.1.1 LINAC-KLYSTRON GALLERY		HV	6.2	172.1	41.6				
1.1.1.1 DC POWER SUPPLIES						164.5	164.5		4.5
1.1.2 LINAC TUNNEL		HVAC	2.6	174.7	43.1			48.2	
1.1.2.1 RF-COMPONENTS & MAGNETS								32.9	
1.2 INJECTOR BUILDING		HV	15.7	331.8	79.0				
1.2.1 EQUIPMENT									
1.2.1.1.1 INJECTION KICKER									
1.2.1.1.2 PULSED INJECTION SEPTUM									
1.2.1.2 DIPOLE POWER SUPPLY						2182.625	4365.25		190.0
1.2.1.3 QUADRUPOLE POWER SUPPLY						562	1124		48.9
1.2.1.4 SEXTUPOLE POWER SUPPLY						54.5	109		4.7
1.2.1.5 CORRECTION POWER SUPPLY						0.875	70		3.0
1.2.1.6 RF DC POWER SUPPLY						1754.4	2083		90.7
1.2.1.7 KLYSTRON 350.8MHz						50	667		396.0
1.2.1.8 AMPLIFIER 43.88MHz						1	1		
1.2.1.9.1 BEAM LINE BM POWER SUPPLY						2.15	2.15		0.1
1.2.1.9.2 BEAM LINE QM POWER SUPPLY						0.29375	3.525		0.2
1.2.2 OFFICE		HVAC	0.6	1.9	6.9			3.5	
1.2.3 LAB		HVAC	1.7	41.1	40.5			10.8	
1.2.4 CONTROL ROOM		HVAC	1.8	41.1	1.8			11.1	
1.2.5 WASH ROOM-WITH SHOWER		HVAC	1.2	0.4	54.0			7.4	
1.2.6 RELAY RACK ROOM		HV	1.2	1.6	3.5			2.1	
1.2.7 ELEVATOR		HV	0.1	10.0	0.0				
1.2.8 UTILITY ROOM		HV	0.1	0.1	3.5				
1.2.9 ELECTRONICS ROOM		HVAC	0.8	40.8	13.5			5.1	
1.2.10 STAIRS		HV	0.4	0.1					
1.2.11 HOIST				5.0					
1.2.12 HATCH									
1.3 SYNCHROTRON									
1.3.1 SYNCHROTRON TUNNEL		HVAC	10.4	690.8	172.2			192.7	
1.3.1.1 EQUIPMENT									
1.3.1.2.1 INJECTION KICKER									
1.3.1.2.2 PULSED INJECTION SEPTUM									
1.3.1.2.3 EXTRACTION KICKER									
1.3.1.2.4 PULSED EXTRACTION SEPTUM									
1.3.1.2.5 THIN DC EXTRACTION SEPTUM									
1.3.1.2.6 THICK DC EXTRACTION SEPTUM									
1.3.1.3 DIPOLE MAGNETS							1022.4		250.3
1.3.1.4 QUADROUPLE MAGNETS							272.7		66.8
1.3.1.5 SEXTUPOLE MAGNETS							55.3		13.5
1.3.1.6 CORRECTION MAGNETS							5.9		1.5
1.3.1.7 RF CAVITY									76.9
1.3.1.8 VACUUM FOR RF CAVITYS (BAKE OUT)				204.0					
1.4 EXTRACTION BUILDING		HV	8.4	245.6	59.4				
1.4.1 EQUIPMENT									

BUILDING	ELECTRIC POWER REQUIRED TO PUMP THE WATER 2X kW-5°C	kW-26.7°C	REFRIGERATE POWER (kW)	POWER LOSS TO AIR (kW)	ELECTRIC POWER TO BE INSTALLED DC POWER SUPPLIES (kVA)	UTILITY (kVA)	CLEAN (kVA)	TOTALS
1. INFIELD BUILDINGS						0.0	0.0	
1.1 LINAC						0.0	0.0	UTILITY PWR
1.1.1 LINAC-KLYSTRON GALLERY						187.7	43.7	585.5
1.1.1.1 DC POWER SUPPLIES	0.0	0.83	0.0	16.5	173.2	0.9	0.0	CLEAN PWR
1.1.2 LINAC TUNNEL	6.0		15.0			208.7	45.3	89.1
1.1.2.1 RF-COMPONENTS & MAGNETS	4.1	0.00	10.2	0.0		15.1	0.0	
1.2 INJECTOR BUILDING			0.0			365.0	83.2	UTILITY PWR
1.2.1 EQUIPMENT			0.0			0.0	0.0	3950.0
1.2.1.1.1 INJECTION KICKER								
1.2.1.1.2 PULSED INJECTION SEPTUM								
1.2.1.2 DIPOLE POWER SUPPLY	0.0	35.42	0.0	183.3	1555.8	37.3	0.0	CLEAN PWR
1.2.1.3 QUADRUPOLE POWER SUPPLY	0.0	9.12	0.0	47.2	635.5	9.6	0.0	83.2
1.2.1.4 SEXTUPOLE POWER SUPPLY	0.0	0.88	0.0	4.6	69.6	0.9	0.0	
1.2.1.5 CORRECTION POWER SUPPLY	0.0	0.57	0.0	2.9	73.0	0.6	0.0	
1.2.1.6 RF DC POWER SUPPLY	0.0	16.90	0.0	87.5	925.3	17.8	0.0	
1.2.1.7 KLYSTRON 350.8MHz	0.0	73.82	0.0	28.0		77.7	0.0	
1.2.1.8 AMPLIFIER 43.88MHz	0.0	0.00	0.0	0.0		0.0	0.0	
1.2.1.9.1 BEAM LINE BM POWER SUPPLY		0.02	0.0	0.1	2.3	0.0	0.0	
1.2.1.9.2 BEAM LINE QM POWER SUPPLY		0.03		0.1	3.7			
1.2.2 OFFICE	0.4		1.1			4.2	7.3	
1.2.3 LAB	1.3		3.3			50.0	42.6	
1.2.4 CONTROL ROOM	1.4		3.5			50.2	1.9	
1.2.5 WASH ROOM-WITH SHOWER	0.9		2.3			5.0	56.8	
1.2.6 RELAY RACK ROOM	0.3		0.6			3.9	3.6	
1.2.7 ELEVATOR			0.0			10.6	0.0	
1.2.8 UTILITY ROOM			0.0			0.1	3.6	
1.2.9 ELECTRONICS ROOM	0.6		1.6			46.1	14.2	
1.2.10 STAIRS			0.0			0.5	0.0	
1.2.11 HOIST			0.0			5.3	0.0	
1.2.12 HATCH			0.0			0.0	0.0	
			0.0			0.0	0.0	
1.3 SYNCHROTRON			0.0			0.0	0.0	UTILITY PWR
1.3.1 SYNCHROTRON TUNNEL	23.9		59.9			834.7	181.3	915.0
1.3.1.1 EQUIPMENT			0.0			0.0	0.0	CLEAN PWR
1.3.1.2.1 INJECTION KICKER								
1.3.1.2.2 PULSED INJECTION SEPTUM								
1.3.1.2.3 EXTRACTION KICKER								
1.3.1.2.4 PULSED EXTRACTION SEPTUM								
1.3.1.2.5 THIN DC EXTRACTION SEPTUM								
1.3.1.2.6 THICK DC EXTRACTION SEPTUM								
1.3.1.3 DIPOLE MAGNETS	0.0	46.66	0.0	102.2		49.1	0.0	181.3
1.3.1.4 QUADROUPLE MAGNETS	0.0	12.45	0.0	27.3		13.1	0.0	
1.3.1.5 SEXTUPOLE MAGNETS	0.0	2.52	0.0	5.5		2.6	0.0	
1.3.1.6 CORRECTION MAGNETS	0.0	0.28	0.0	0.6		0.3	0.0	
1.3.1.7 RF CAVITY	0.0	14.34	0.0	0.0		15.1	0.0	
1.3.1.8 VACUUM FOR RF CAVITYS (BAKE OUT)						214.7	0.0	
			0.0			0.0	0.0	
1.4 EXTRACTION BUILDING			0.0			267.4	62.5	UTILITY PWR
1.4.1 EQUIPMENT			0.0			0.0	0.0	402.1

1.4.1.1 EXTRACTION KICKER	1																					
1.4.1.2 AC SEPTUM POWER SUPPLY	1														0.0	0.00	0.0	0.0		0.0	0.0	CLEAN PWR
1.4.1.3 DC SEPTUM POWER SUPPLY	1														0.0	0.00	0.0	0.0		0.0	0.0	105.2
1.4.1.4 BEAM LINE BM POWER SUPPLY	3										9.8375	29.5125		1.3	0.0	0.24	0.0	1.2	31.1	0.3	0.0	
1.4.1.5 BEAM LINE QM POWER SUPPLY	19										1.8125	34.4375		1.5	0.0	0.28	0.0	1.4	36.3	0.3	0.0	
1.4.2 ELECTRONICS ROOM	1	9.2	5.8		53.36		HVAC	1.7	41.1	13.5			10.7		1.3		3.3			49.9	14.2	
1.4.3 WASH ROOM-UNISEX	1	2.7	2	2.7	5.4		HVAC	0.2	0.1	27.0			1.1		0.1		0.3			0.7	28.4	
1.4.4 ELEVATOR	1	1.4	1.4		1.96		HV	0.2	10.0	0.0							0.0			10.7	0.0	
1.4.5 STAIRS	1	4.4	1.9		0.36		HV	0.1	0.1								0.0			0.2	0.0	
1.4.6 HOIST	1								5.0								0.0			5.3	0.0	
1.4.7 HATCH	1	3.4	2.5		8.5												0.0			0.0	0.0	
																	0.0			0.0	0.0	
1.5 RF BUILDING	2	38.6	29.3	5.5	2261.96		HV	24.4	295.0	67.9							0.0			336.2	71.5	UTILITY PWR
1.5.1 EQUIPMENT																	0.0			0.0	0.0	10751.1
1.5.1.1 SR DIPOLE POWER SUPPLY	1											1032.5		44.9	0.0	8.38	0.0	103.3	1086.8	8.8	0.0	CLEAN PWR
1.5.1.2 DC RF POWER SUPPLY	2											8832		226.6	0.0	42.24	0.0	883.2	8870.5	44.5	0.0	114.1
1.5.1.3 KLYSTRON (350MHz--1MW)	2											6668		1584.0	0.0	295.29	0.0	333.4		310.8	0.0	
1.5.1.4 KLYSTRON FOCUSING MAGNET POWER SUPPLY	2															0.00	0.0	0.0	40.4	0.0	0.0	
1.5.1.4 KLYSTRON FOCUSING MAGNET	2													10.4	0.0	1.94	0.0	0.0		2.0	0.0	
1.5.1.3 EMERGENCY GENERATOR	1																0.0			0.0	0.0	
1.5.1.4 BOOSTER PUMP- 26.7°C WATER	1																0.0			0.0	0.0	
1.5.1.5 BOOSTER PUMP- 5°C WATER	1																0.0			0.0	0.0	
1.5.2 EQUIPMENT ROOM	1	9.3	6	5.5	55.8		HVAC	1.8	41.1	13.5			11.2		1.4		3.5			50.2	14.2	
1.5.3 WASH ROOM-UNISEX	1	2.7	2	2.7	5.4		HVAC	0.2	8.1	27.0			1.1		0.1		0.3			0.7	28.4	
																	0.0			0.0	0.0	
2. STORAGE RING & EXPERIMENTIAL HALL	1		27	10	30196.8		HVAC	326.1	624.9				6034.1		749.9		1874.8			3764.0	0.0	
• OUTSIDE CIRCUMFERENCE		1203.2							752.0	752.0							0.0			791.6	791.6	
• INSIDE CIRCUMFERENCE		1033.6							646.0	646.0							0.0			680.0	680.0	UTILITY PWR
2.1 EQUIPMENT																	0.0			0.0	0.0	19406.5
2.1.1 DC POWER SUPPLY-QM,SX & CORR	20											6376.6		1387.5		258.67	0.0	255.1	6712.2	272.3	0.0	CLEAN PWR
2.2 CRANE	2																0.0			0.0	0.0	3210.0
2.3 TRUCK AIR LOCK	4	10	7	6	280		HVAC						56.0		7.0		17.4			25.6	0.0	
2.4 BEAM LINE EQUIPMENT (EACH BEAM)	76								1900.0	1140.0		1292		351.4		65.51	0.0	912.0		2069.0	1200.0	
2.4 STORAGE RING TUNNEL	1	1060	4.2	2.8	4452		HVAC	48.1	152.1	424.0	0.4		809.6		110.6		276.4			618.0	446.3	
2.5.1 EQUIPMENT																	0.0			0.0	0.0	
2.5.1.1 DIPOLE MAGNET	80											992		256.3	0.0	47.78	0.0	49.6		50.3	0.0	
2.5.1.2 AUX. DIPOLE COILS	80											75		19.4	0.0	3.62	0.0	3.8		3.8	0.0	
2.5.1.3 QUADRUPOLE																	0.0			0.0	0.0	
2.5.1.3.1 (0.8-m)	80											619.7		160.1	0.0	29.85	0.0	31.0		31.4	0.0	
2.5.1.3.2 (0.6-m)	80											485.4		125.4	0.0	23.38	0.0	24.3		24.6	0.0	
2.5.1.3.3 (0.5-m)	240											1239.4		320.9	0.0	59.71	0.0	62.0		62.9	0.0	
2.5.1.4 SEXTUPOLE (MAIN-0.3-m)	280											685.4		177.1	0.0	33.01	0.0	34.3		34.8	0.0	
2.5.1.4.1 SEXTUPOLE (HORZ COR DIPOLE)	280											862.6		222.9	0.0	41.55	0.0	43.1		43.7	0.0	
2.5.1.5 COR MAGNET (VERT DIPOLE)	240											300.1		77.5	0.0	14.45	0.0	15.0		15.2	0.0	
2.5.1.5.1 (VERT & HORZ DIPOLE)	78											195.1		50.4	0.0	9.40	0.0	9.8		9.9	0.0	
2.5.1.6 RF CAVITY	16											1256		341.6	0.0	63.69	0.0	62.0		67.0	0.0	
2.5.1.7 BEAM LINE EQUIPMENT (EACH BEAM)	76								1900.0	760.0		1216		330.8		61.66	0.0	40.0		2064.9	800.0	
2.5.1.8 VACUUM EQUIPMENT (BAKE OUT)	20								2040.0								0.0			2147.4	0.0	
2.5.1.9 VACUUM EQUIPMENT	106								310.0	79.5		80	21.8		2.7		6.8			344.7	83.7	
2.5.1.10 BEAM LOSS TO VACUUM SYSTEM	1											2928	796.4		99.0		247.4			364.7	0.0	
																	0.0			0.0	0.0	
3. CENTRAL LAB AND OFFICE COMPLEX	1						HVAC										0.0			0.0	0.0	UTILITY PWR
3.1 MAIN OFFICE AND LAB							HVAC										0.0			0.0	0.0	1550.1
3.1.1 OFFICE	162	3.4	3.4		1872.72		HVAC	60.7	20.5	550.9			374.2		46.5		116.3			256.8	588.3	CLEAN PWR
3.1.2 LAB	54	8.9	5.9		2835.54		HVAC	91.9	69.0	729.0			566.6		70.4		176.0			429.7	767.4	1552.5
3.1.3 CONTROL ROOM	1	10.2	10.6		192.92		HVAC	6.3	15.5	40.5			30.6		4.8		12.0			40.5	42.6	
3.1.3.1 UTILITY ROOM	1	8.9	3.4		38.26		HVAC	1.8	40.0	13.5			6.0		0.8		1.9			46.8	14.2	

3.1.4 COMPUTER ROOM	1	18.2	10.6		192.92		HVAC	6.3	15.5	40.5			38.6		4.8		12.0			40.5	42.6	
3.1.4.1 UTILITY ROOM	1	8.9	3.4		30.26		HVAC	1.0	40.8	13.5			6.8		0.8		1.9			46.8	14.2	
3.1.5 CONFERENCE ROOM		8.9	5.9		0		HVAC	0.0	40.5	0.0			0.0		0.0		0.0			42.6	0.0	
3.1.6 LIBRARY		8.9	5.9		0		HVAC	0.0	40.5	0.0			0.0		0.0		0.0			42.6	0.0	
3.1.6 WASH ROOM	16	5.6	4.5		403.2		HVAC	13.1	4.2	28.8			80.6		10.0		25.0			55.0	30.3	
3.1.7 BUILDING UTILITY ROOM	4	6.1	3.4		82.96		HVAC	0.9	4.3	4.6			16.6		2.1		5.2			13.1	4.8	
3.1.8 ELEVATOR	2	3.1	2.2		13.64		HVAC	0.4	10.1				2.7		0.3		0.8			12.4	0.0	
3.1.9 ELEVATOR	1	2	1.1		2.2		HVAC	0.1	10.0				0.4		0.1		0.1			10.8	0.0	
3.1.10 BASEMENT	1	83.8	30.2		2530.76		HVAC		208.6	45.6			505.7		62.9		157.1			451.1	48.0	
3.1.11 HALLS	1	240.3	2.2		528.66		HVAC	5.7	6.6				105.6		13.1		32.8			61.3	0.0	
																	0.0			0.0	0.0	
3.2 HI BAY AREA	1						HVAC										0.0			0.0	0.0	UTILITY PWR
3.2.1 MACHINE SHOP	1	23.8	14.5		345.1		HVAC	11.2	156.8	38.3			69.0		8.6		21.4			208.4	40.3	1173.1
3.2.1.1 WELD SHOP	1	14.5	5.9		85.55		HVAC	2.8	82.5	20.4			17.1		2.1		5.3			97.6	21.5	CLEAN PWR
3.2.2 STOCK ROOM	2	14	5.9		165.2		HVAC	1.8	42.2	27.0			33.0		4.1		10.3			61.4	28.4	502.7
3.2.3 TRUCK AIR LOCK	1	14.8	6.1		90.28		HVAC	1.0	2.1	3.6			18.0		2.2		5.6			11.5	3.8	
3.2.4 TRUCK DOCK-RECEIVING	1	14	8.4		117.6		HVAC	1.3	3.6	3.6			23.5		2.9		7.3			15.9	3.8	
3.2.5 HI BAY	1	45.3	25		1132.5		HVAC	12.2	292.9	78.3			226.3		28.1		70.3			424.8	74.0	
3.2.5.1 CRANE	1						HVAC		20.0				0.0		0.0		0.0			21.1	0.8	
3.2.6 CLEAN ROOM	2	18.2	7		254.8		HVAC	0.3	77.6	58.0			50.9		6.3		15.8			113.7	52.6	
3.2.6.1 AIR LOCK	1	8.1	2.8		22.68		HVAC	0.2	1.4	3.6			4.5		0.6		1.4			3.8	3.8	
3.2.6.2 AIR LOCK	1	7	2.5		17.5		HVAC	0.2	1.3	3.6			3.5		0.4		1.1			3.2	3.8	
3.2.7 TUNNEL HATCH	3	2.5	2.5		18.75		HVAC						3.7		0.5		1.2			1.7	0.0	
3.2.8 HALLS	1	22.4	2.8		62.72		HVAC	0.7	1.8				12.5		1.6		3.9			8.3	0.0	
3.2.9 WASH ROOM-SHOWERS & LOCKERS	2	3.5	5.9		41.3		HVAC	0.4	1.6	7.2			8.3		1.0		2.6			5.9	7.6	
3.2.10 LARGE LABS	10	14.5	5.9		855.5		HVAC	27.7	83.9	250.0			171.0		21.2		53.1			195.7	263.2	
																	0.0			0.0	0.0	
4. LAB & OFFICE MODULES	4						HVAC										0.0			0.0	0.0	UTILITY PWR
4.1 OFFICE	20	3.4	3.4		924.8		HVAC	30.0	10.7	69.0			184.8		23.0		57.4			127.4	72.6	552.5
4.2 LABS	4	8.9	5.9		840.16		HVAC	27.2	49.2	54.0			167.9		20.9		52.2			157.3	56.8	CLEAN PWR
4.3 CLEAN ROOM	1	8.9	5.9		210.04		HVAC	6.8	42.7	13.5			42.0		5.2		13.0			71.3	14.2	165.4
4.4 WASH ROOM	2	5.6	3.3		147.84		HVAC	4.8	1.5	14.4			29.5		3.7		9.2			20.2	15.2	
4.5 CONFERENCE ROOM-DAY ROOM	1	11.9	11.3		537.88		HVAC	5.8	24.5	6.3			107.5		13.4		33.4			80.9	6.6	S.R. OUTSIDE
4.6 UTILITY ROOM	1	4.8	4.8		92.16		HVAC	1.0	2.1				18.4		2.3		5.7			11.7	0.0	+ L.&O. M. +
4.7 HALLS	1	129.4	1.4		724.64	8	HVAC	7.0	8.6				144.8		18.0		45.0			83.6	0.0	1 MED BEAM
																	0.0			0.0	0.0	UTILITY PWR
5. AUDITORIUM	1	24	24		576		HVAC	6.2	46.5	13.5			115.1		14.3		35.8			108.2	14.2	1071.6
5.1 HALLS		152	4.8		0		HVAC	0.0					0.0		8.9		0.0			0.0	0.0	CLEAN PWR
																	0.0			0.0	0.0	812.9
6. MAIN UTILITY BUILDING	1						HV										0.0			0.0	0.0	
																	0.0			0.0	0.0	
7. INTERCONNECT TUNNEL	1	243.4	4	4	973.6		HV	10.5	64.1								0.0			78.5	0.0	
																	0.0			0.0	0.0	
8. MEDICAL TREATMENT BUILDING									69.6	78.6			347.5		43.2		100.0			232.3	82.7	
																				0.0	0.0	
9. SITE ACCESS																				0.0	0.0	
																				0.0	0.0	
9.1 ROADS																				0.0	0.0	
9.1.1 ALL WEATHER			7.1																	0.0	0.0	
9.1.2 ACCESS			7.1																	0.0	0.0	
9.2 PARKING LOTS																				0.0	0.0	
9.2.1 CENTRAL OFFICE & LAB COMPLEX																				0.3	0.0	
9.2.1.1 • LOT 1	1	204.2	53.4		10904.28			46.0												48.4	0.0	
9.2.1.2 • LOT 2	1	91.4	19		1736.6			7.3												7.7	0.0	
9.2.1.3 • LOT 3	1	65.3	40.4		2638.12			11.1												11.7	0.0	
9.2.2 EXPERIMENTER MODULES	4	61.7	19		1172.3			4.9												5.2	0.0	
9.2.3 RF BUILDING	2	33.2	20.2		670.64			2.8												3.0	0.0	

9.2.4 INJECTOR BUILDING	1	7.1	7.1		50.41
9.2.5 EXTRACTION BUILDING	1	7.1	3.6		25.56
9.3 ROAD TUNNEL	1	49.9	0		
SUB TOTALS					
TOTAL					

9.2.4 INJECTOR BUILDING			0.2						
9.2.5 EXTRACTION BUILDING			0.1						
9.3 ROAD TUNNEL									
SUB TOTALS			881.6	12308.4	6670.9			11676.0	6836.5
TOTAL									

9.2.4 INJECTOR BUILDING						0.2	0.0	
9.2.5 EXTRACTION BUILDING						0.1	0.0	
9.3 ROAD TUNNEL						0.0	0.0	
SUB TOTALS	1451.1	1274.5	3627.7	3370.9	20215.5	20571.9	7022.0	
TOTAL						40787.4	7022.0	